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D2.3 SHARE SRA topics and priorities relating to medical radiation protection

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Abbreviations

AI	Artificial intelligence
EURAMED	European Alliance for Medical Radiation Protection Research
ML	Machine Learning
rocc-n-roll	Radiation prOteCtion Concept: strategic research agenda aNd ROadmap interLinking to heaLth and digitisation aspects
RRI	Responsible Research and Innovation
SHARE	European platform for social sciences and humanities research on ionising radiation
SRA	Strategic research agenda
SSH	Social sciences and humanities

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The opinions stated in this report reflect the opinions of the authors and not the opinion of the European Commission.

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1. EXECUTIVE SUMMARY

The goal of the EURAMED rocc-n-roll Project is to propose an integrated and coordinated European approach to research and innovation in medical applications of ionising radiation and related radiation protection, based on stakeholder consensus and existing research agendas of radiation protection platforms and related activities. As part of this endeavour, the strategic research agendas of the European research platforms would be reviewed to identify and prioritise relevant elements. The goals of Task 2.3 were to discuss SSH research as presented in the SHARE SRA, to identify topics relevant to EURAMED rocc-n-roll and to clarify any gaps in research needs.

The goals were accomplished via two main routes: 1) a EURAMED rocc-n-roll Panel was appointed to participate in a review of the existing SHARE SRA and to hold discussion on relevant topics and 2) interaction between Task 2.3 and the SRA Working Group of SHARE was established to ensure a wider consultation with SSH voices could be taken into account.

The key outcomes from Task 2.3 activities were:

- Completion of a full review of the SHARE SRA on the social and humanities aspects of ionizing radiation in light of the EURAMED rocc-n-roll focus on medical applications and radiological protection.
- Recognition that the majority of the existing SHARE SRA has relevance to the field of radiological protection relating to medical applications and that specific relevance is notable in the context of the growing digitalisation of health and medicine.
- Production of a version of the SHARE SRA that centers on research relating to medical applications and associated radiation protection needs.
- Identification of the priority to ensure integration of SSH research in future programmes on medical radiation applications, to ensure societal context is centrally embedded in the development and implementation of new technologies and working practices.
- Recognition that, while patient involvement is a critical aspect of stakeholder engagement in research in medical radiation applications, there are two major challenges to be addressed: i) stakeholder engagement is uneven geographically across Europe and across medical applications and ii) all members of society will be a ‘patient’ at some point. Therefore, the notion of ‘patient’ in stakeholder discourse must be broadened.
- Awareness that focused attention to equality, diversity and inclusion is necessary at all stages of research and development, particularly in light of systematic exclusion that has been present in some areas of past medical research.

The first ever medical applications-oriented SHARE SRA is presented in Section 4. However, we note that SRAs must be ‘live documents’ and – particularly in the case of SSH research – sensitivity to contexts and change over time will necessitate ongoing dialogue on research priorities.

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2. INTRODUCTION TO THE SHARE SRA

The aim of the overall SHARE Strategic Research Agenda (SRA) is to contribute to the improvement of the radiological protection system and the governance of radiological risks and applications of ionising radiation by coordinating SSH research; supporting specialised, as well as transdisciplinary education and training; enhancing stakeholder involvement, knowledge management and sharing; and identifying gaps in SSH state of the art across disciplines. Enabling SSH research to play a fuller and stronger role through a coordinated SRA mechanism is intended to ensure that societal perspectives on research, policy and practice related to ionising radiation are acknowledged and accounted for.

The relevance and priority of a broad range of issues and topics relating to the presence of, exposure to, and/or the medical applications of ionising radiation have been explored through the Task 2.3 activity that is reported here. This Deliverable outlines the topic priorities for Social Sciences and Humanities (SSH) research that relate to medical radiation protection that are for further consideration in light of the overarching EURAMED rocc-n-roll goals.

Adapting the principles first described in Perko et.al. (2019), the underpinning tenets that inform the resulting research agenda and priorities identified in this Deliverable are that:

- SSH should support existing and future research, policy, and practice, in all areas relating to radiological risks and benefits of medical applications of ionising radiation, to better take into account the concerns, values, expectations and needs of a wide range of stakeholders, including citizens;
- SSH research should be coordinated, shared, and integrated into existing scientific and technical research and development (R&D) on medical applications; hence, collaboration with other European research platforms, research groups and relevant associations must be an integral component of the agenda, especially in identifying joint areas of prioritisation;
- Research and innovation relating to medical applications of ionising radiation should be conceived of as transdisciplinary and inclusive, integrating science, citizens' and other stakeholders' inputs from the start;
- SSH research should integrate insights from other application fields to applications in the medical context, as well as from recent methodological evolutions in SSH, and societal changes in general.

The overarching SHARE SRA is structured along six main Research Lines:

- Research line 1: Social, political, psychological, historical, and economic factors influencing perceptions, expectations and behaviours regarding radiological protection and applications of ionising radiation.
- Research line 2: Holistic approaches to governance of ionising radiation exposure situations
- Research line 3: Responsible Research and Innovation in radiological protection and applications of ionising radiation
- Research line 4: Stakeholder engagement practices in relation to radiological protection and applications of ionising radiation
- Research line 5: Risk and health communication.
- Research line 6: Radiological protection culture.

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Those 6 research lines were subject to review in collaboration with the EURAMED rocc-n-roll Panel, SHARE SRA Working Group and other experts, and the main discussion points are outlined below. Task 2.3 activities did not include consideration of overlaps between the SHARE SRA and the SRAs of ALLIANCE, NERIS, EUDRADOS or MELODI.

3. DEVELOPMENT OF THE SRA AND INTEGRATION TO TASK 2.3 ACTIVITY

The process of development of the original SRA is described elsewhere (Perko et al, 2019). Subsequently, major changes in the organisation of SSH research in ionising radiation have taken place, including the formal establishment of the SHARE Platform in July 2019 and the drafting of a Joint Radiation Protection Roadmap for radiological protection research[1] (Impens, Salomaa et al, 2020). From the start, we acknowledged that effective adaptation of the SSH research agenda would require continuous engagement with concerned parties, particularly the European technical and research platforms related to radiological protection and the variety of applications of ionising radiation. This has taken place in various forms, including meetings with new technical platforms groups; and prioritisation exercises within the CONCERT project, among others. Following the establishment of the SHARE Platform, a task force was set up to review once more the SRA, with the intention to take a holistic view on radiological protection and to explicitly include all civil applications (industrial, medical, energy) of ionising radiation, and the presence of radioactive materials in the environment. The proposal from the task force was opened for consultation with the SHARE community and radiation protection platforms on June 9th, 2020 (until August 1st) and the input received was documented and taken into consideration in a revision to the first SRA. Further feedback on the resulting text was collected during a special session devoted to the SHARE SRA organised at the RICOMET 2020 conference, on September 3rd, 2020. The current version of the full SHARE SRA is available on the website (www.ssh-share.eu)

Within the EURAMED rocc-n-roll project, the discussion of the relevance of SSH has continued with specific reference to the medical applications agenda. Revision of the SHARE SRA was therefore timely and prior consideration of medical applications in SHARE discussions has integrated well into EURAMED's agenda to further develop its SRA as part of the overall EURAMED rocc-n-roll SRA.

In Task 2.3, an opening workshop and discussion was held in Nov. 2020. Attendees included EURAMED rocc-n-roll partners, technical experts, and social sciences experts. At this workshop, each topic focus of the SHARE SRA's 6 *research lines* was considered in the context of medical radiation protection research. Multiple perspectives were voiced on the extent to which the SHARE topics were relevant to the medical context and views were gathered on the relative priority, primarily in terms of the urgency of timescale on which the research should be addressed. Meeting notes were collated for further discussion and consideration following the workshop close.

An outcome of the discussion was that, to some extent, all research lines of the SHARE SRA had relevance to the EURAMED rocc-n-roll scope. This is not surprising given that the social contexts within which medical radiation protection research occurs is of critical relevance. One major area of concern requiring more development was identified as the impact of digitalisation in health. It is therefore noted here that Task 2.3 has some overlap with Task 4.3 where a focus

[1] Impens N., Salomaa S., et al. (2020). D3.7 Second joint roadmap for radiation protection research. EJP-CONCERT European Joint Programme for the Integration of Radiation Protection Research. https://www.concert-h2020.eu/Publications.

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on the ethical challenges of data and AI in medical applications of IR is being studied in greater depth.

In early 2021, the SHARE SRA Working Group met to discuss our SRA, including the relations to, and overlaps with, EURAMED concerns and the output from the Task 2.3 workshop. Subsequently, work began in drafting a version of the SHARE SRA which *centred* medical applications at the core of the research lines and key questions. A further panel workshop was unable to be scheduled and, as mitigation, discussion continued through correspondence with relevant parties. The first version of a SHARE SRA centred on medical applications is presented in the next section.

4. RESEARCH LINES, TOPICS AND PRIORITIES

Within SSH, efforts must be made to be as inclusive as possible as the field incorporates multiple disciplines and professional fields; the research field is multifaceted which makes it difficult to find terminology suitable for all purposes.

We adopt certain terminological conventions in organising the SRA, but this does not mean rejection of alternative approaches. Concurrently, and convergent with Challenge H of the Joint Radiation Protection Research Roadmap (Impens, Salomaa et al, 2020), the topics below aim at developing new SSH theories, concepts, practices, and methodological tools related to medical applications, radiation protection and translation of research and innovation. This deliverable, while written for the EURAMED rocc-n-roll project, is addressed to the largest possible audience engaged in expert debates and decision-making and aims at stimulating transdisciplinary interchange among researchers, policymakers, and civic society representatives.

The term *SSH* is understood as inclusive and as follows: branches of knowledge such as sociology, political science, communication studies, economics, psychology, or cultural anthropology, whereas humanities cover in particular philosophy, ethics, law, and historiography. These disciplines each have their own research methods, whether qualitative, (e.g. in-depth interviews, focus groups, observations etc.), quantitative (e.g. surveys, cost-benefit calculations etc.) or mixed (e.g. social multi-criteria analyses, social network analyses etc). Within SSH research activity, the appropriate research design must be generated – using relevant methods, theory, and approach to analysis – in order to address the research questions that need to be answered. Thus, for SSH, research design is a dynamic process and acquires particular nuances when SSH research is conducted in collaboration with non-SSH disciplines, such as found in research relating to medical applications of ionizing radiation.

The term *stakeholder* is used to denote any *"individuals or groups (institutional and non-institutional), with a tangible or intangible (yet to be shaped or discerned) interest in the radiation exposure situation and the related radiological protection issues. These may be affecting decisions, be affected by the formulation and resolution of a problem or challenge, or represent an affected party (humans or the environment). In this perspective, stakeholders are constructed in interaction with actors, issues, contexts"*[2]. Stakeholders comprise formal institutions, as well as actors without a predefined institutional role that have to manage their own decision-making processes, stakes, and expectations. These stakeholders might be affected by the exposure to ionising radiation, conduct work (research or practice) in this or related fields, have a legal role in the governance and management of radiological risk in

[2] Turcanu C., Abelshausen B., Geysmans R., Van Oudheusden M., Meskens G., Schieber C., Schneider T., Zeleznik N., Pölzl-Viol C. 2019. Final report of the ENGAGE project. CONCERT Deliverable D9.94. www.engage-concert.eu

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medical applications, or act as proxy for other stakeholders (e.g. patient groups representing specific groupings of stakeholder), among others.

Research line 1: Social, political, psychological, historical and economic factors influencing perceptions, expectations and behaviours regarding radiological protection and medical applications of ionising radiation

In the original SHARE SRA document, research line 1 (RL1) aims at understanding how different actors make sense of, and take decisions related to, radiological hazards and risks. This would apply to both natural and human-induced radiation, thus ranging from radon exposures, to medical, industrial and research applications, and covering the entire nuclear fuel cycle of nuclear energy production up to, and including, radioactive waste management.

RL1 covers a range of topics addressing the interrelation between individual and societal strategies to interpret and cope with radiological risks, and the various psychological factors (notably risk perception, attitudes, and practices), economic factors and social factors, notably knowledge, culture, and historical memory, among others. It is relevant to various forms of current, future or potential radiological exposures and covers different **exposure contexts** (including medical related contexts); invited and uninvited participation; different cultures and different socio-economic and demographic factors.

The various factors (social, economic, psychological) influencing the perception of radiation-induced risk is an important topic that is relevant to medical radiation protection research. Why are there different perceptions of risk? How can we understand the reasons for differences and act on them in relation to medical application contexts and exposure situations? We know that physicians, for example, should be expected to inform patients about radiation-induced risks. Therefore, it is important to investigate referring physicians' perception of risk and the extent to which this duty is carried out and in what ways. The physician's information will, however, not be the only source of information that a patient would incorporate into their understanding e.g. on risks and benefits of treatment. We can also anticipate that a patient's risk perception will depend on the type of medical issue and proposed treatment, as well as life expectancy issues. For example, patients with thyroid cancer receiving I-131 may have long life expectancy and are exposed to high doses. These patients can be expected to be interested in radiation-induced risks and the various factors influencing the risk. Clinician and researcher experience indicates that such perceptions of risk vary widely, and the reasons are little understood. We note also that different technical models of radiation risk estimation have been developed and that there are uncertainties in these that are acknowledged by scientific communities. How ideas of risk and uncertainty are understood scientifically needs to articulate with other stakeholders' understandings in a way that is meaningful.

The conclusion is that different understandings of ionising radiation concepts, risks, and uncertainty, between and within various stakeholder groups must be explored as a priority.

Prioritised research topics include:

1.1. Understanding the factors (social, economic, psychological) influencing individual strategies to cope with perceived risks, and expectations in the use of ionising radiation in medical contexts. This topic must extend its scope beyond the specific individual patient and incorporate other relevant individuals in order to build a comprehensive knowledge base e.g. family members, future patients.

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1.2. Exploring the different understandings of ionising radiation concepts, risks, and uncertainty between and within various stakeholder groups and the respective amplification or attenuation of radiological risks. For example, differences between medical and other stakeholder groups; and influence of external factors on understanding, such as media.

1.3. Understanding of trade-offs in decision-making, e.g. non-radiological considerations, and why some of these are more important in some situations e.g. in particular countries, for certain contexts, treatment regimes etc.

1.4. Investigating those factors influencing perception of radiological risks by individuals and groups exposed to both high and low radiation doses.

Research line 2: Holistic approaches to governance in research and practice in medical applications of ionising radiation

Research line 2 (RL2) focuses on holistic approaches to governance, in this case, in research and practice relating to medical applications. Governance can be understood as 'the process of governing' a social system (in this case the social system dealing with ionising radiation in medical applications) through formal (institutional) and informal (social) dynamics, taking into account relevant social and natural phenomena and being driven by various interests, values and norms.

A holistic approach to governance of medical applications of ionising radiation specifically, therefore, implies that attention is paid to the broader context in which health and medical issues emerge, evolve and resolve. Particular attention should be paid to the interlinkages with other societal issues, for example, the ways in which access to health care is unevenly distributed across societies, and the socio-economic disparities that lead to uneven distributions in health outcomes for some groups. Worth noting is that the definition or choice of the 'broader context' can have a normative character open to interpretation. For example, in the medical context of 'health governance', the use of radiation for diagnosis and therapy needs to take into account values of precaution and informed consent, as well as the equality of access to treatments.

The requirement for a holistic approach can be understood as the need for governance that takes into account all relevant facts, values, interests, scientific developments, hopes, hypotheses, beliefs and concerns, with the aim to generate synergetic insights that have the potential to be trusted by those involved in, and affected by, ionising radiation exposure situations. Aspects of concern include, but are not limited to, (i) integration of scientific, technical, social, and political aspects in the decision-making processes; and (ii) raising public awareness of these aspects and integrating them into knowledge building. A core emphasis here is on providing insights and guidance on multi-dimensional, multi-actor and multi-institutional decision-making and policymaking and on addressing emerging trade-offs in the governance of ionising radiation in medical exposure situations.

A significant focus of attention will be where conflicts arise between the various aspects attended to in a holistic approach. For example, there may be conflict of interest between radiation safety and the production of medical equipment. Manufacturers may be more interested in staying ahead of their competitors and achieving economic imperatives rather than producing the safest equipment, or equipment that delivers value for money in health systems with constrained financial resources. We can see, therefore, a need to link research on medical innovation with wider societal and economic considerations in understanding governance concerns.

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We know from medical controversies elsewhere (e.g. opioid crisis in USA) that it can be the case that manufacturers and practitioners are sometimes more interested in promoting technologies, treatments and exams than informing stakeholders about relevant risks and consequences. There may be situations of over- or unnecessary, diagnosis and treatment, while acknowledging that under treatment is also a concern. It remains unclear to what extent individuals are aware of any radiation induced risks associated with screening and whether health systems have appropriate governance in place in relation to this. Awareness of radiogenic risks is also related to justification of exposures, and this is a topic that deserves research.

Whereas RL1 is about individuals and group of individuals, RL2 attends to the social systems i.e. the way societies organise themselves and how decisions are made in relation to that organisation. We acknowledge that there is dynamic interaction between individuals and systems and research in either research line needs to be mindful in this regard.

It was noted that the ethical foundations of the ICRP system of radiological protection differs from the system of medical ethics. Understanding the interface of these systems is imperative. We note an overlap with RL2 and EURAMED rocc-n-roll Task 2.6 (Evaluation of regulators' needs and expectations relevant to medical radiation protection research) and suggest further exploration of the joint areas of interest should be incorporated into the future EURAMED rocc-n-roll SRA.

Prioritised research topics include:

2.1. Understanding the production of 'good' governance (holistic, participatory, deliberative, sustainability thinking, capacity building, sense for cooperation, transparency, reflexivity, accountability, robustness, adaptability, traceability, …) and enabling its enaction in contexts relating to medical applications.

2.2. Analysis of existing policy and regulation related to governance of medical-related exposure situations, to identify and disseminate policies and best practice.

2.3. Analysis of the values and principles that inform radiological protection programmes and practices in the medical field with a view to develop tools and methods to elaborate such programmes.

2.4. Assessment of how various types of uncertainties (i.e. scientific, technical, social, and ethical) are identified and managed in different professions, for instance general practitioners, surgeons, and in publics, and the impact on governance systems.

2.5. Evaluation of the evolution in governance systems, practices, and ethics, over time, and recommendations for Radiation Protection in Medicine.

Research line 3: Responsible Research and Innovation in medical applications of ionising radiation

Research line 3 (RL3) aims at assessing how research, development and innovation related to the use of ionising radiation and radiological protection are conducted, with the aim of inciting more socially responsive and ethically sound processes and outcomes. The design of transdisciplinary activities is emphasised in RL3, for example through co-creation agenda setting processes that engage scientists from various disciplines (sciences, engineering, medicine, social sciences and humanities) and between disciplines and publics.

The topics addressed in RL3 investigate how a concept like Responsible Research and Innovation (RRI) can be used in technical R&D concerning medical applications, and how interventions might structure productive interactions between different actors in this regard.

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Although different conceptualisations of responsible research and innovation exist, and both methodological tools and the practices of deployment vary, RRI is viewed as a critically important idea to implement in research and development projects and programmes. Research processes and the development of innovation in industry must be conducted in a responsible manner and the extent to which this the case is an important topic for research. The dynamic between regulation and innovation is a complex one and better understanding of this dynamic is key to ensuring appropriate development and deployment of new technologies. One major area of concern is the rapid rise of artificial intelligence and machine learning within medical applications. The rise of AI and ML raises a wide range of matters of concern that require research attention. For example, the privacy of patient data is already recognized as important but the challenges around privacy and trust in ML systems are underexplored. We note the close link between RL3 and the EURAMED rocc-n-roll Task 4.3 on ethics and data protection issues related to medical applications and radiation protection research. More detail on the research priorities in this area are being investigated in Task 4.3 and the output from that Task (due in M33) should be read in conjunction with the RL3 material presented here.

Prioritised research topics include:

3.1. Examining the social, cultural, economic, (geo)political and historical context of research in medical applications of ionising radiation, with particular focus on the rationales, possibilities, and limitations of research approaches and methods, as well as the social relevance of research hypotheses.

3.2. Enhancing the reflexive awareness of actors involved in technical R&D about the societal implications of technology developments in medical applications, including implications of research, development and use of AI and ML.

3.3. Ascertaining conflicts of interest in the field of medical applications, including, in research associated with medical applications of ionising radiation, technology development, and in radiological protection research, and finding ways to manage such conflicts.

3.4. Establishment of a collaborative framework for stakeholder engagement in research and development, policy and practice in ways that enhance responsiveness to societal needs and concerns (in connection with RL4)

   a. Developing methodologies and tools for the dynamic mapping of stakeholders' concerns, views and needs to identify R&D priorities in the development of medical applications and radiological protection.

   b. Determining how to make SSH integration meaningful and effective for all stakeholders through, for example, characterising, developing and operationalising principles such as transdisciplinarity.

Research line 4: Stakeholder engagement approaches and practices in relation to medical applications of ionising radiation

Research line 4 aims at fostering stakeholder engagement in research, policy and practice related to radiological protection and research on medical applications of ionising radiation. This research line considers how (formal or informal) participation practices are enacted by various actors and in different contexts. These cover different socio-economic, political, and cultural contexts, different exposure situations (planned and emergency), and the different

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stages in the cycle from knowledge generation to policy formulation and practical implementation.

The specificities of medical contexts addressed in particular research projects requires clear attention to particular dimensions of RL4; the development and assessment of stakeholder and public participation tools and methodologies for different exposure situations, and the assessment of existing policies and practices.

Stakeholder engagement in research, policy and practice related to medical radiation protection and applications of ionising radiation is acknowledged as an important topic for the EURAMED SRA. Approaches to engagement most likely vary geographically and across other variables. We know that medical professions will approach engagement differently. We also know that the capacity to engage is dependent on a number of social variables e.g. socio-economic status. For some diseases, patient groups are highly effective in shaping the development of knowledge yet for others this influence is absent and may have implications. Understanding the full landscape of stakeholder engagement would be a key first step to identifying good practice and areas for prioritization for further research.

Prioritised research topics include:

4.1. Development of approaches for effective stakeholder engagement and understanding of the specific challenges related to medical applications of ionising radiation.

4.2. Exploration of the needs, possibilities and processes required to engage patients in informed decision-making in a holistic approach perspective, including analysis of the needs of patients, caregivers, and patients' representatives for participation and access to information, and evaluation of whether and how these are reflected in legal requirements and governance frameworks.

4.3. Analysis, comparison, and evaluation of formal practices for mediation and facilitation between authorities, scientists, publics and other stakeholders for medical applications, with due attention to issues of representativeness.

4.4. Understanding of how stakeholder engagement feeds back into the development of knowledge, technologies and policies, and institutional practices.

4.5. Understanding the challenges for maintaining engagement and participation over the long term. These include the development of participation cultures, the preservation of knowledge, and the institutional contexts that enable or hinder public participation in decision-making processes.

Research line 5: Risk and health communication

Risk communication needs to be *"evidence-based (e.g., based on the qualitative and quantitative empirical data, surveys, experiments), theory-based (e.g., drawing from empirically-supported theories of health behavior, information processing, risk perception and risk communication) and strategic (e.g., based on formats and methods that have been proven to reach its preconceived objectives)"*[3].

This research line covers issues related to communication of risk. Key questions include how the exchange or sharing of risk-related data, information, and knowledge between and among different parties (such as regulators, experts, consumers, media, general public) can be

[3] Bouder, F., Perko, T., Lofstedt, R., Renn, O., Rossmann, C. et al. The Potsdam radon communication manifesto, *Journal of Risk Research*, DOI: 10.1080/13669877.2019.1691858

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successfully provided. RL5 also covers understanding the practices of communicating health information e.g. public health campaigns related to ionising radiation in medical exposure situations; doctor-patient communications, in order to address personal choices for health related actions. RL5 aims at developing research to support communication about ionising radiation between different stakeholders and citizen-centred risk communication, in order to clarify choices and options in a variety of exposure situations. It also seeks to empower citizens and other stakeholders to make more informed decisions.

A particular challenge is how to improve the benefit/risk dialogue between health professionals and other stakeholders. This dialogue is important for patients with specific diseases and is context-dependent on the exposure situation, for example, patients with benign diseases would need to comprehend benefits and risks before starting radiotherapy sessions and this understanding can be expected to be different in the case of non-benign diseases.

Prioritised research topics include:

5.1. Development of structured approaches to identify needs for information and to develop timely communication tailored to the needs of patients and families, including, considerations related to social identities (ethnicity, religion gender), as well as the methods and tools for effective evaluation of said communications.

5.2. Evaluation of different approaches to risk communication to improve radiation protection in medical applications (e.g. instrumental approach, risk message approach, risk governance approach, normative, dialogue, etc.).

5.3. Development of models and tools for risk and health communication targeted to specific exposure situations e.g. low doses and specific places e.g. waiting rooms.

5.4. Effective communication of uncertainties (including use of visualisation) and how this influences perceptions, attitudes, and practices. This includes investigation of potential causes for misinterpretation related to the presentation of information (e.g. format, design, data, and uncertainty).

5.5. Risk and health communication about radiological protection principles in medical applications of ionising radiation and the impact of communication on radiological protection behaviour e.g. in health workplaces.

Research line 6: Radiological protection culture

Research line 6 involves research concerning the assessment and development of a radiological protection culture among all concerned stakeholders, in various exposure situations and for the different categories of exposed individuals (workers, patients, general public). Radiological protection culture is a still evolving concept and is of composite nature, characterised by a set of perceptions, values, attitudes, beliefs, and expectations related to radiation risk; an assembly of knowledge, know-how, regulations, skills, experience, and practices; and a dynamic building process based on multi-stakeholder interactions, including regulatory bodies and all concerned parties.

From a general point of view, the aims of radiological protection culture are manifold. First, it favours an understanding of radiological protection norms and standards. Second, it enables individuals to reflect on their own protection and that of others, to consciously consider radiological protection aspects in their lives and contributes to decision-making processes related to the management of radiological exposure situations. Thirdly, it enables professionals

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in radiological protection and other stakeholders to participate in a dialogue, to share a common language, with a view to enhance decision-making processes associated with the implementation of the radiological protection system and to better address the concerns of all stakeholders.

Practically, the specific elements characterizing radiological protection culture, the aim of radiological protection culture, as well as the tools or methods of dissemination will depend on the exposure situations as well as on the stakeholders involved in the management of situations. Clearly this is important for medical radiation protection research and particularly for research related to medical radiation workers.

Relevant cross-cutting topics include:

6.1. Characterisation of radiological protection culture(s) relevant to the fields of medical applications of ionizing radiation, including: how regulatory practices shape radiological protection culture; the relationships between radiological protection culture and more general safety or security cultures in medical contexts; the interaction between radiological protection culture at the levels of organization group and individual; analysis of processes of radiological protection knowledge production, values and expectations.

6.2. Understanding the impact of evolving technologies, knowledge, and communication technologies on radiological protection culture, particularly the rise of computational approaches, AI, and ML.

6.3. Analysis of the role and benefits of building and enhancing radiological protection culture in medical application contexts, for the improvement of health and well-being of populations and individuals.

6.4. Integration of radiological protection culture within the development of a broad safety culture to help stakeholders to consider risks in a holistic manner. For example, identification of tools and processes allowing participation of stakeholders at the relevant level; development of education and training schemes adapted to target stakeholders.

5. CONCLUSION

This Deliverable has aimed to capture the range of perspectives and discussion of the major areas of SSH research relevant to the context of medical applications of ionising radiation and associated radiation protection research needs. Section 4 has outlined a first version of an SSH research agenda based on the work of the Task 2.3 contributors. Further opportunities to explore the research needs will present themselves over time and a crucial next step will be consideration of the research needs in the broader remit of EURAMED rocc-n-roll goals. The task for SSH research is large and will need to draw on an extensive list of disciplines and fields to make the necessary advances. Monitoring of the draft SRA will need to be ongoing, particularly as new technologies develop and seek implementation. There will be a continuous need to identify emerging gaps in research needs and ensure responsiveness to the broad agenda of medical applications. Additional topics may become more pertinent as further knowledge and awareness arises around the increasing use of radionuclides in medical applications, for example. Novel technological developments will require responsiveness from societal research. In particular, from discussions during Task 2.3 and as part of Task 4.3, we recognise that SSH research must respond to the increasing digitalisation of health systems, datafication of health and wellbeing in everyday life, and advances in AI and ML within the medical context.

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The key outcomes from Task 2.3 activity were:

- Completion of a full review of the SHARE SRA on the social and humanities aspects of ionizing radiation in light of the EURAMED rocc-n-roll focus on medical applications and radiological protection.
- Recognition that the majority of the existing SHARE SRA has relevance to the field of radiological protection relating to medical applications and that specific relevance is notable in the context of the growing digitalisation of health and medicine.
- Production of a version of the SHARE SRA that centres on research relating to medical applications and associated radiation protection needs.
- Identification of the priority to ensure integration of SSH research in future programmes of work on medical radiation applications, to ensure societal context is centrally embedded in the development and implementation of new technologies and working practices.
- Recognition that, while patient involvement is a critical aspect of stakeholder engagement in research in medical radiation applications, there are two major challenges to be addressed: i) stakeholder engagement is uneven geographically across Europe and across medical applications and ii) all members of society will be a 'patient' at some point. Therefore, the notion of 'patient' in stakeholder discourse must be broadened.
- Awareness that focused attention to equality, diversity and inclusion is necessary at all stages of research and development, particularly in light of systematic exclusion that has been present in some areas of past medical research.

As can be seen from the range of research themes and topics described in Section 4, a full range of SSH research is of broad relevance to all aspects of the medical applications agenda that is the concern of EURAMED rocc-n-roll. Unlike in technical research, where a priority list for research may be defined using specific criteria (e.g. improvement in cost-benefit; healthy-life-years gained), the SSH research topics are contextual to the medical scenario under discussion. This suggests that specific priorities become defined by the particular medical scenario under scrutiny and cannot be identified outside of that context.

The disciplines and fields of SSH do of course have their own priorities and these would vary according to which research discipline was undertaking a prioritisation exercise. There would not, for example, necessarily be agreement between sociological and health communications researchers, as the focus of these fields' study are not automatically commensurate. This highlights the need for cross-discipline research within SSH as well as collaboration between SSH and technical and medical fields.

Task 2.3 activities did not include consideration of overlaps between the SHARE SRA and the SRAs of ALLIANCE, NERIS, EUDRADOS or MELODI. Future work will want to consider joint areas of interest across all Platforms in relation to the medical applications agenda. We recommend that all research platforms work together to solidify the research agenda at the confluence of medical, technical, social, and ethical dimensions and that EURAMED rocc-n-roll should consider this as part of its SRA.

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